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PHYSICS

Shanghai Becomes an Important Experimental Base of CAS

40081051b Shanghai WEN HUI BAO in Chinese 15 Aug 89 p 1

[Article by reporters Huang Xin [7806 6580] and Jin Dan [6855 0030]: "CAS's Shanghai Experimental Base Takes Shape"]

[Text] The Chinese Academy of Sciences' (CAS) four high-technology experimental base areas (bioengineering, chemistry and new materials, microelectronics, and radiation technology), built and expanded in Shanghai during the Seventh 5-Year Plan, are taking shape. They will become a major force in the development of new industries in Shanghai.

The CAS has established seven biological research organs in Shanghai with strong S&T staffs in bioengineering. They are one of China's life-science research centers and are recognized by the world's biology circles. The Shanghai Bioengineering Experimental Base will become a guiding force in genetic engineering. It will carry out developmental and intermediate testing research in cellular engineering, microbial engineering, and enzyme engineering, convert "upstream" bioengineering research achievements as quickly as possible into "downstream" products, and will seek broad applications of the newest achievements in industry, agriculture, medicine, the environment, and other fields. At the start of construction of this base, attention was given to major efforts to organize these S&T forces to carry out scientific R&D activities and several scientific research achievements have now been made. They have developed a highly sweet low-calorie nutritional additive—sweet dipeptide—200 times sweeter than sucrose; this is good news for sufferers of obesity, diabetes mellitus, and hypertension and will generate rather high socioeconomic benefits.

The Shanghai Microelectronics Research and Development Base, a joint investment by the Shanghai Municipal Government and the CAS employs microelectronics research forces in the CAS Shanghai Metallurgy Institute, has been completed and placed into trial operation in the Caohejing Development Zone. It has developed horizontal relationships with relevant nearby plants, institutions of higher education, research organs, and so on to form a unified deployment for high-technology-product R&D, intermediate testing, and production, and it has formed an industrial park centered on development of large-scale integrated circuits, fiber-optic communications, and other high technologies. It has made several achievements in R&D on application-specific integrated circuits [ASIC's].

A transformed and expanded Chemical New Materials Intermediate Testing Base, formed from the CAS Shanghai Silicate Institute and Organic Chemistry Institute pilot plant, selected several highly knowledge- and technology-intensive development programs during the construction process and took full advantage of the former pilot plant to conduct intermediate testing in an effort to develop new materials and new technologies as quickly as possible.

The CAS Shanghai Atomic and Nuclear Institute joined with relevant departments in Shanghai Municipality to build the Shanghai Radiation Technology Intermediate Testing Base, which has now been placed into operation. This base area can carry out radiation freshness preservation processing of 20 tons of vegetable and fruit products each hour, and it can develop radiation sanitization of medical treatment apparatus and instruments, radiation curing of materials and products, radiation modification of materials, and other services. This base has established cooperative relationships with over 10 units in Shanghai Municipality for close integration of nuclear technology applications, R&D, and utilization.

Multi-Layer Reasoning Method-Based Expert System for Remotely Sensed Image Interpretation

40090004a Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 10-15

[English abstract of article by Chen Gujuan [7115 6253 3197] of the Eighth Design Department, Shanghai Astronautics Bureau]

[Text] In this paper, the concept of a knowledge learning, knowledge representation and reasoning method is introduced into image pattern recognition. A computer vision expert system involving remotely sensed image interpretation has been designed and executed to realize the above concept.

A new reasoning method, i.e., a multi-layer reasoning method, has been derived. This method is capable of dealing properly with incomplete and erroneous knowledge. In addition, a series of special rules used in the multi-layer reasoning procedure can be produced automatically by the inductive learning method from some of the interpreted samples. Therefore, the system is more intelligent than others.

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Identification of Torque Characteristics of Flexible Joint Nozzle

40090004b Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 16-22

[English abstract of article by Yang Shixue [2799 0013 1331] of Shaanxi Power Machinery Research Institute]

[Text] The torque characteristics of the flexible joint nozzle have been analyzed and a mathematical model for identifying the torque characteristics has been developed based on the response curve of the total torque vs the sweep angle. A cubical spline function was used to render more exactly the contrary equations represented by the mathematical model. Finally, the spring torque, viscous friction torque, coulomb friction torque, inertia torque and offset torque, comprising the total torque, and their coefficients are obtained by multivariant linear regression analysis. A simulation experiment has been carried out on a computer, thereby verifying the established mathematical model and the analysis method.

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Guidance Flight Mechanics Method

40090004c Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 30-38

[English abstract of article by Zhu Wenxuan [2612 2429 6513] of the Beijing Automatic Control Engineering Institute]

[Text] In researching an inertial guidance system, we set up dynamic equations for a ballistic rocket and solved them in the inertial frame (fixed direction). The centrifugal and coriolis inertial force did not have to be taken into consideration, but the original conditions for when the rocket left the earth's surface had to be given correctly. The author explains the aerodynamic force of the atmosphere as it acts upon the moving rocket in inertial space and gives the method for computing this force. It is known that the atmosphere is dragged by the earth's gravitation and rotates with the earth. The author infers a formula to compute the geographic latitude and longitude, as well as the moving parameters for the rotating earth, employing parameters in the fixed frame.

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Research for Asymmetrical Aerodynamic Characteristics of Reentry Body

40090004d Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 45-50

[English abstract of article by Zhang Lumin [1728 7627 3046] of the China Aerodynamic Research and Development Center]

[Text] The effect of the asymmetrical aerodynamic derivative of static and dynamic stability on the rolling resonance of a reentry body is described. This is stimulated by the 6-D equations of motion. The mechanism of inducing asymmetrical aerodynamic characteristics is described. A small asymmetrical force for a typical body is calculated by means of the approximate and numerical methods. The results show that there is a law of variation for small asymmetrical aerodynamic force when such reentry body geometric parameters as semi-angles and nose bluntness are involved. This is important when designing reentry bodies.

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Non-Overshoot Design for Gyro Test Turntable Servo System

40090004e Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 51-56

[English abstract of article by Liu Shengcai [0491 0581 2088] and Zhang Song [1728 2646] of Harbin Institute of Technology]

[Text] The non-overshoot design problem involving a gyro test turntable servo system is studied in this paper. After comparing the different control methods used in China and abroad, a scheme using two feedback loops to be switched under the proper conditions has been adopted. This results in higher accuracy as well as better dynamic performance.

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CAA of Static Error of D/A Converter

40090004f Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 65-69

[English abstract of article by Guo Yanying [6753 5888 3853] of the Beijing Institute of Radio Metrology and Measurement]

[Text] The static error of a D/A converter (linear and differential error) is mainly determined by the precision of the resistor network of the D/A converter. One of the main tasks in designing a D/A converter involves determining the tolerance of network resistors according to the desired static performance, or predicting and analyzing the static error of the D/A converter for a known resistor network. In this paper, the Monte-Carlo computer simulation approach is proposed for such CAA. Finally, a 10-bit D/A converter is taken as an example to illustrate the realization of the CAA.

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Optimization of Excitation Coefficients of Multi-Beam Antenna Feeds

40090004g Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 70-78

[English abstract of article by Chen Jianbo [7115 3386 3134] and Wang Jueqi [3769 3635 7496] of the Institute of Spacecraft System Engineering, China Aerospace Technical Research Institute]

[Text] The optimization of the amplitudes and phases of the feed excitation coefficients of a multi-beam antenna is discussed using the Maxmin criterion. A exact mathematical model of the problem is given, emphasizing the characteristics of the problem, i.e., the object function is an indifferentiable multipeak function. Therefore, the "complexity method" is used to conduct the optimization. Taking the conditions in China into consideration, three practical questions are discussed, i.e., rain loss and weighting, the division of the east and west parts of the territory, and the grouping of the feed coefficients.

From the optimization of an example, it can be seen that the amplitude of the field of the weakest station has been greatly improved and that the field of the entire service area tends to be uniform.

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Multivariable Adaptive Decoupling Theory, Its Application to Missile Control System

40090004h Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 79-86

[English abstract of article by Li Yanping [2621 1750 1627] and Zhou Fengqi [0719 7685 1477] of Northwestern Polytechnical University]

[Text] The content of this paper is devoted to a multivariable adaptive control technique. With the coupled structure being studied, the authors apply the model-matching method and adaptive control technique to design a linear time-varying and strong coupled plant. The stability of the adaptive systems and their output convergence are proved. Through digital and hybrid simulations, the results demonstrate that the control system design of a missile is practical.

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Spacecraft Modeling with Flexible Appendages, Model Truncation

40090004i Beijing YUHANG XUEBAO [JOURNAL OF CHINESE SOCIETY OF ASTRONAUTICS] in Chinese No 4, Oct 89 pp 87-95

[English abstract of article by Liu Tun [0491 2557] and Yang Daming [2799 1129 2494] of Harbin Institute of Technology]

[Text] The attitude dynamic equations of a spacecraft with a central rigid body and flexible appendages are derived. Expanding these equations in series by both unconstrained and constrained mode shape functions, the state equations in the time domain and the inverse transfer function matrix, defined as the relationship of the augmented attitude angle matrix to the control forces or moments in the frequency domain, are obtained. The relative motion of the flexible appendages to the central rigid body is also derived. This paper proposes two modal identities, one of which can be regarded as the criterion for the truncation of higher order equations obtained when the attitude control system is analyzed.

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Key Biotechnology Projects of 863 Plan Listed

90CF0262A Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 8 Jan 90 p 2

[Article: "Themes and Special Topics in Biotechnology for 863 Plan Established—Projects With Three Themes and 20 Special Topics Established"]

[Text] Theme 1: New high-output, superior-quality, and reversion-resistent animal and plant varieties

Theme 2: New drugs, vaccines, and genetic treatments

Theme 3: Protein engineering

20 Special Topics

1. Selective breeding of new high-output hybrid rice varieties

2. Biotechnology breeding of resistant crops

3. Genetically engineered improved crop proteins

4. Development and utilization of biological symbiotic nitrogen-fixation capabilities

5. Development of artificial seeds

6. Biotechnology breeding of primary livestock and poultry varieties

7. Research on using biotechnology to improve the reproduction rate of dairy cattle

8. Biotechnology breeding of cultured fish varieties

9. Research on new techniques and methods for animal and plant genetic engineering

10. Development of genetically engineered vaccines

11. Development of genetically engineered polypeptide drugs

12. Research on guidance drugs

13. Research on target-product separation and purification engineering

14. Research on applications of biotechnology to treat hepatitis B

15. Research on applications of biotechnology to treat cardiovascular diseases

16. Research on applications of biotechnology to treat malignant tumors

17. Research on genetic diagnosis and treatment of hereditary diseases

18. Basic research in biotechnology

19. Transformation of enzymes and proteins for primarily medical uses

20. Research on basic technologies for protein engineering

I. The First Theme for Biotechnology in the 863 Plan—New High-Output, Superior-Quality, and Reversion-Resistant Plant and Animal Varieties

The theme of new high-output, superior-quality, and reversion-resistant plant and animal varieties in the field of biotechnology is composed of nine special topics and 39 topics. They concern major research projects in agriculture, animal husbandry, and aquaculture for selective breeding of new high-output hybrid rice varieties, biotechnology breeding of resistant crops, genetic engineering for crop protein improvement, development and utilization of organic symbiotic nitrogen-fixation capabilities, development of artificial seeds, biotechnology breeding of primary livestock and poultry varieties, using biotechnology to improve dairy-cattle reproduction rates, biotechnology breeding of cultured fish varieties, research on new techniques and methods for animal and plant genetic engineering, and so on. A total of 64 units and 121 laboratories in the Chinese Academy of Sciences [CAS], State Education Commission, Ministry of Agriculture, and local scientific research organs are participating in all types of research work in the various thematic projects. Over 800 S&T personnel are directly involved in the research work. There is comprehensive responsibility by theme experts over all areas in the scientific-research management system from plan formulation to fund allocation and daily administration. The first theme expert group is composed of seven people. The group chairman is Professor Hong Mengmin [3163 1322 3046] of the CAS Shanghai Plant Physiology Institute.

The 863 Plan emphasizes the spirit of fairness, devotion, realism, innovation, and cooperation. Since its implementation began at the end of 1987, it has strictly adopted the two measures of selecting superior responsible units and "rolling." Every responsible unit and all personnel responsible for tasks have a relatively good foundation, and they have both a spirit of cooperation and an understanding of competition. This has ensured a high rate of progress in all aspects of research work on the themes. After more than 2 years, most topics are proceeding smoothly according to plan. Of the 11 tasks specified for the Seventh 5-Year Plan in the theme task document, with the exception of one task which will require further debate and improvement in technical lines, 6 of the tasks are basically completed and it may be possible to complete the other 4 projects in 1990. The two-system method used in the area of selective breeding of new high-output hybrid rice varieties for cross-breeding of varieties has already resulted in cultivation of a few dozen new series of varieties which do not develop a photosensitive sensory nucleus and are suitable for local cultivation, including one series of varieties which have already passed examination and acceptance. Production demonstrations have already begun in several provinces and autonomous regions for superior combinations with 5 percent and greater increases in

output compared to the controls. Production demonstrations of two-system-method hybrid japonica rice are being carried out on nearly 10,000 mu in Hubei Province in 1990 and the Guangxi Zhuang Zu Autonomous Region has made trial plantings of two-system-method hybrid indica rice on more than 1,000 mu in 1990. The hybrid system planting situation in all provinces is that production demonstrations of two-system-method interplanted hybrid combinations may cover 300,000 mu in 1990. There are also several two-system-method sub-interplanted hybrid rice combinations being tried out and they are now undergoing experimental examination and acceptance. There is hope that the trial plots may cover about 1,000 mu in 1990. These newest developments will play an immeasurably positive role in substantially increasing rice output in China. Considerable progress has been made in the area of biotechnology breeding of crop resistance. The CAS Microbiology Institute has already converted the cucumber mosaic virus [CMV]-resistant satellite cDNA monomer and dimer genes which they synthesized and structured themselves via plant expression carriers into lycochromosomes and obtained a new tomato product series with transferred genes. In the area of biological symbiotic nitrogen fixation capacity development and utilization, during molecular genetics research on rizobium and plant host interrelationships, the CAS Shanghai Biochemistry Institute and Plant Physiology Institute made several new discoveries at international levels regarding azotabacter-nodule-formation gene-expression control mechanisms. In the area of research and applications of high-efficiency nitrogen-fixing soybean forage grass rizobia, they obtained engineered bacteria clusters capable of competing in the field. In small-region experiments, they can increase output by 30 kilograms per mu compared to the controls. They will be extended for experiments over a large area in soybean producing regions in 1990. In basic research topics on genetic engineering to increase grain crop photosynthetic efficiency, they have completed research on ribulose-1.5-diphosphate carboxylation/oxidase large and small sub-base dissociation and recombination, and they have completed artificial synthesis of small sub-base structural genes for this enzyme. In research on protoplast cultivation, high-efficiency plant formation, and cell fusion technologies, after continuing with wheat protoplast cultivation regenerating plants done by the CAS Genetics Institute and other organs, the CAS Shanghai Plant Physiology Institute also recently achieved success in research on protoplast cultivation regeneration plants in sorghum for the first time. In the area of biotechnology breeding of primary livestock and poultry varieties, the CAS Developmental Biology Institute and other units completed biological hormone chromosome-construction gene cloning and examination and acceptance for Changbai pigs and cloning and examination and acceptance work for pig group hormone-releasing-factor genes. In research on dairy-cattle embryonic cleavage and other cell engineering technologies, after continuing with the successful completion of dias embryo transplantation of peasant family oxen by the CAS Genetics Institute and other organs, they also achieved success for the first time in China in producing calves via tetrad embryo transplantation in dairy cattle. In the area of research on external maturation of dairy-cattle oocytes and "test-tube" calf technologies, China's first "test-tube" calf was born without problems at the Inner Mongolia Experimental Animal Center on 15 August 1989. The second and third "test-tube" calves were born on 2 September and 21 September in the same laboratory. Two days later, on 23 September, another "test-tube" calf which was developed from a frozen external embryo was born at the Jiangsu Provincial Academy of Agricultural Sciences Veterinary Institute. Moreover, several "test-tube" calves will be born at the Chinese Academy of Agricultural Sciences College Livestock Institute, Guangxi Agricultural College, Northeast China Agricultural College, and other research units. The successive births of these "test-tube" calves shows that China has entered advanced world ranks in this new-technology and high-technology research realm.

At the Shanghai Strategic Report Conference in May 1989, after the State Science and Technology Commission proposed that a further orientation toward agriculture be made in the biotechnology realm, the theme expert group immediately organized experts and scholars in all areas to formulate several new measures. On the basis of smooth implementation of existing research topics, they also suggested undertaking certain new research projects like disease-resistant breeding of wheat-cell engineering and chromosome engineering, plant-resource utilization, and so on. At the annual theme work conference held not long ago, the delegates again revised theme, special topic, and topic work plans for 1990. They also discussed plans for the theme in the Eighth 5-Year Plan and offered several positive opinions and proposals for further adherence to the principle of "using S&T to invigorate agriculture" during the Eighth 5-Year Plan. It can be expected that smooth implementation of existing topics and the establishment and implementation of some newly established topics certainly will have positive effects on agricultural production in China in the near future, particularly a substantial increase in output in grain production. It will continually provide society with more high-technology products and gradually form several new industries.

II. The Second Theme for Biotechnology in the 863 Plan—New Drugs, Vaccines, and Genetic Treatments

The second theme concerns applications of biotechnology in the areas of medicine and health. It will focus on several highly dangerous and hard to prevent diseases like hepatitis B, malignant tumors, cardiovascular diseases, and so on. Limited goals have been selected for focused development of research work. Biotechnology will be used to study many types of genetically engineered vaccines, new types of polypeptide drugs, guidance drugs, and other effective biotechnology products. At the same time, they will use molecular biology to study the pathogenesis of several malignant diseases in

an attempt to use genetic engineering methods for treatment. In the area of vaccines, they are focusing on hepatitis B, hepatitis A, epidemic hemorrhagic fever, cholera, dysentery, rotavirus, EB, virus, blood flukes, and other malignant and infectious diseases to develop new types of highly effective genetically engineered vaccines; they are focusing at the same time on several types of polyvalent or bivalent vaccines with immune protection actions against various diseases. In the area of new types of polypeptide drugs, the research is employing genetic engineering methods to produce new polypeptide and protein drugs. Examples include new types of genetically engineered interferon, new types of genetically engineered interleukin, tumor necrosin, superoxide dismutase, auricle peptide for treatment of cardiovascular diseases, human apolipoprotein, and so on. Guidance drugs are a vigorous research topic in biotechnology. Development of guidance drugs for leukemia, liver cancer, lung cancer, gastric cancer, and other diseases is now in progress. Work using Chinese herbal drugs, toxoproteins, or antibiotics as "bullets" to kill cancer cells is also underway.

New international developments in biotechnology are actively being tracked to diagnose or treat malignant or genetic diseases. This project has also arranged for a substantial proportion of applied basic and basic research work. Examples include research on using cancer gene expressions and their products to explore treatment of malignant tumors, research on human cancer-resistant genes, the role of the eukaryocyte control sequence in highly effective expression, research on processing and modification of genetically expressed products, new genetic expression carriers, expression systems, and so on.

To form biological high technologies into industries quickly and generate their appropriate social and economic benefits, this project has established three integrated research and development centers to concentrate upstream and downstream advantages to develop genetically engineered vaccines, genetically engineered drugs, and genetically engineered biological products. At the same time, they have organized staffs to study the necessary separation and purification media and techniques for use in manufacturing biotechnology products.

All these research topics are included in the nine special topics and three integrated research and development centers under the second theme. The establishment of all special topics, centers, and topics has gone through strict evaluation and examination according to the principle of unified public bidding, equal competition, and selection of the best for admission and with attention to the progress situation and additionally to "rolling," meaning that some moved in and some moved out, for implementation by responsible personnel and units.

The plan for the second theme has been in effect for over 2 years now. Although this is not a very long time, gratifying progress has been made. The new injectable genetically engineered interferon has passed pharmaceutical inspection. The new hepatitis-A surface antigen vaccine and new interleukin have now entered the intermediate testing stage. Many other topic plans are now providing smoothly. Projections are that after 1 or 2 years, laboratory research on even more products will be completed and they will enter the intermediate testing stage. Achievements in the areas of basic research and applied basic research will become enormous reserve strength technologies and potential for biotechnology in China. It can be expected that by the end of this century and the early part of the next century, biotechnology in the pharmaceutical field will form a new emerging industry. Pharmaceutical biotechnology in China will attain international levels in several important areas and make the necessary contribution to safeguarding the people's health.

III. The Third Theme for Biotechnology in the 863 Plan—Protein Engineering

Protein engineering is a scientific discipline which did not emerge until the early 1980's. It is based on an understanding of the relationship between protein structure and function and proposes programs for directional transformation of natural proteins using genetic engineering methods to give them even better functions and greater applied value. Its appearance has pushed man's understanding of and capacity for transforming organic molecules to new heights and is of major theoretical significance only in academic terms but also has revealed captivating applications prospects and economic benefits. For this reason, international research on protein engineering has developed extremely quickly. China's 863 Plan has made protein engineering the third theme in the realm of biotechnology. This theme includes two special topics.

The first special topic is protein engineering for enzymes and proteins with primarily medical uses. It mainly involves research on the structure and function of insulin, trypsin inhibitor, subtilisin, and several other proteins. With the aid of computer graphic displays and auxiliary design, genetically engineered techniques are used to transform genetic structures and directionally revise protein molecules in an attempt to obtain proteins with properties better than natural ones.

The second special topic is research on basic technologies in protein engineering. The focus here is on research on molecular design in protein engineering, external genetic modification, and other new methods to provide technical reserves in genetic engineering for protein engineering in China.

The primary task in the second special topic is to study new methods of molecular design and genetic engineering in conjunction with the first special topic to prepare the conditions for further development while at the same time establishing and training a scientific research staff.

Since work on this theme began in 1987, the clear task indicators for the topics and specific expenditure guarantees, as well as a set of reformed management methods, have led to rather rapid progress in the work and the attainment of achievements with preliminary significance.

Research on Developing Reagents To Prevent, Cure Chemical Neurotoxicants Reported

40081051c Beijing GUANGMING RIBAO [GUANGMING DAILY] in Chinese 5 Aug 89 p 3

[Article by Wu Yali [0702 7161 7787]: "A Record of Attacks on Key Problems in Preventing and Curing Chemical Neurotoxicants—A Visit to the Chinese Academy of Military Medical Sciences"]

[Excerpt] [passage omitted]

During the mid-1950's, the recently established Chinese Academy of Military Medical Sciences began doing research on pharmaceutical prevention and emergency treatment of neurotoxicants. Although neurotoxicants are hypertoxic externally they are quite insipid; they have no color or odor and look almost like distilled water. Thus, they are not easily detected when released by the enemy. Once they are sensed, more than half the toxin has already entered the body and one's life is in danger. Therefore, a medicine for neurotoxicant prevention and emergency treatment must be rapidly pharmacodynamic, highly antitoxic, and easy to use. The technical difficulty of meeting these three requirements simultaneously is rather great.

Researchers at the Chinese Academy of Military Medical Sciences first of all studied the toxicosis mechanisms of neurotoxicants. The primary action of organic phosphate toxins on the human body is cholinesterase inhibition. After cholinesterase inhibition, acetylcholine, the chemical transmitter of cholinergic nerves (the human body's most important neurotransmitter system), cannot be hydrolized and accumulated. This creates several severe functional disorders which lead to death. Thus, cholinesterase reactivation is a basic measure for treating nerve toxicity. At the same time, they also noticed that although an anticholinergic agent provided only temporary relief of symptoms, it can sustain life to ensure that the reactivated agent functions, so they decided to focus their research on cholinesterase reactivation agents and anticholinergic agents.

At that time, foreign countries had studied "pyridine-2-aldoxime methyl iodide" (PAM), which could be used as an actual reactivation agent. However, it had low solubility and was inconvenient to use, so it did not meet the requirements for emergency treatment under emergency conditions. Thus, all countries were searching for a better reactivation agent. After many years of study, researchers at the Chinese Academy of Military Medical Sciences eventually discovered that by substituting chlorate for iodate in PAM, the synthesized "pralidoxime chloride" [2-PAM-Cl] was effective and more soluble. Moreover, its toxicity was low and it was absorbed quickly. After injecting a small dog suffering from organic phosphate toxin with pralidoxime chloride and anticholinergic agent, this small dog which had been on the verge of death stopped convulsing and was quickly able to stand and walk. The scientific research personnel were sincerely happy about their success but discovered that these two medicines had certain shortcomings so they did not wallow in the job of their success and began a new attack on the problem.

First, they focused on two key questions. One, they wanted to enable the preventive agent which protected cholinesterase and emergency treatment medication which reactivated cholinesterase to enter the central nervous system because it is extremely easy for a neurotoxicant to pass through the blood-brain barrier and "create disorder" in the central nervous system. Second, there should be an obvious reduction in toxic side effects of the anticholinergic medication. Battlefield conditions are extremely complex. If emergency treatment medication is administered erroneously due to mis-diagnosis and has substantial side effects, this is the same as disintegrating one's own fighting forces. Thus, there always is a search for medication with both good antitoxic results and limited side effects. The scientific research personnel discovered, however, that all medications with good antitoxic effects had major side effects while those with few side effects had very poor antitoxic performance. This was a contradiction, and foreign countries felt it was hard to resolve completely.

Faced with these two contradictions, research personnel at the Chinese Academy of Military Medical Sciences began with the dialectic method and felt resolutely that although it would be too difficult to achieve a total solution to these two contradictions within a short time period, there was hope that a substantial step could be made. They collected nearly 10,000 types of plants and chemical compounds from throughout China and sifted through all of them. They also did structural and functional analysis experiments for those selected and after more than 10 years of unremitting efforts and continual improvements they eventually separated and synthesized several new types of emergency treatment medication for use as neurotoxicant prevention agents unique to China. Their cholinesterase protection and cholinesterase reactivation agents can enter the central nervous system and they have strong medicinal effects and few side effects. There is also an anticholinergic agent with comprehensive action and few side effects. There was an obvious improvement in antitoxic action after these medications were mixed. Their ability to enter the central nervous system greatly surpasses international levels. This medication has received a state S&T progress award and state invention award as well as a state natural sciences award for theoretical research in this area. In 1986, a comprehensive three-preventions project (prevention of atomic weapons, prevention of biological weapons, and prevention of chemical weapons) which included a research project by the Chinese Academy of

Military Medical Sciences on "medical protection from wartime special weapons injuries," received a special state S&T progress award. This is China's highest S&T award and the only special S&T progress award given to medical circles since the nation was founded.

Biotechnology Achievements in Shanghai

40081051d Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 3 Jul 89 p 1

[Article by special reporter Ling Bingmo [0407 4426 2875]: "Shanghai Becoming Important Biotechnology Base—Using Scientific Research and Experiment Measures To Take Advantage of Technical Strengths"]

[Text] After several years of work, biotechnology in Shanghai has formed definite advantages in the areas of scientific research forces, experimental measures, and achievement levels and it is becoming one of China's main bases in development of biotechnology.

Shanghai now has 103 scientific research academies and institutions, institutions of higher education, and production plants involved in biotechnology research and development work. Over 6,000 S&T personnel are engaged in research work, about one-third of the total in China.

There have been gradual improvements in experimental measures and facilities. The Chinese Academy of Sciences [CAS] Shanghai Institute of Biochemistry's Molecular Biology Laboratory, the CAS Shanghai Institute of Plant Physiology's Plant Molecular Genetics Research Laboratory, the Shanghai Municipal Tumor Institute's Oncogene-Cloning Laboratory, and Fudan University's Genetic Engineering Laboratory have now been completed and opened to the outside. Construction is being speeded up at CAS's Shanghai Bioengineering Experimental Base which received an investment of more than 60 million yuan. Construction has begun at the Shanghai Nucleotide Industry Experimental Base and other facilities. This has created favorable conditions for undertaking basic research in bioengineering and trial development.

Shanghai's biofermentation and biologically prepared products including zymin, antibiotics, organic acids, amino acids, vitamins, steroid hormones, nucleotide materials, yeast, alcohol, acetone, butyl alcohol, and other biotechnology products as well as traditional brewed food products now constitute an industrial colony with a substantial scale. Incomplete statistics for the end of 1984 for these industries show 650 million yuan in gross industrial output value and profits of 220 million yuan. Projections are that the gross industrial output value will rise to 1.24 billion yuan in 1990. Nearly U.S. $100 million in foreign exchange has been earned from antibiotics (tetracycline), citric acid, vitamin C, urea products, and steroid hormones. Shanghai workers involved in biotechnology production have a rather strong concept regarding the acceptance of new technologies and their technical levels are relatively high. They have now adopted several new technologies to transform food products and traditional pharmaceutical industry technologies and accumulated experience to establish new industries.

Several high-level biotechnology scientific research achievements have appeared in Shanghai. There have been successes in genetic cloning of human tumors, human insulin, anti-hepatitis B surface antigen, penicillin acylase, and genetically engineered bacteria for K88 and K99 piglet yellow dysentery, and they have been expressed in the acceptors. In the area of microbial fermentation, they have selectively bred glycoside, proline, lysine, glutamine, citric acid, lactic acid, gentamicin, penicillin, erythromycin, jinggangmycin, and other bacteria which have replaced the originally produced bacterial varieties and substantially increased output and product quality.

Shanghai has led or participated in developing many topics including among biotechnology topics in key state S&T projects. Expenditures allocated to Shanghai for special project tasks now account for one-third of total state expenditures for attacks on key problems in the field of biotechnology. The Shanghai Municipal Government has given them extremely close attention and they have made R&D in biotechnology one of the high technology realms for focal development in Shanghai Municipality. The Shanghai Municipal Science and Technology Commission and Economic Commission allocated a specific proportion of expenditures to match state investments for special use in biotechnology research and development. Shanghai has become one of China's main base areas for key attacks in the field of biotechnology.

Development of GaAs, Other Light-Emitting Devices

90CF0161B Beijing WULI [PHYSICS] in Chinese Vol 18 No 9, Sep 89 pp 519-524

[Article by Xu Xurong [1776 0650 8833] of the Center for Materials Physics, Tianjin Institute of Technology]

[Excerpts] Abstract: Using the development of science and technology in the world as the background, this report introduces the work done in areas such as physics, materials, devices and applications with specific reference to luminescence. In practical applications (including applied basic research), China already has its own devices with special characteristics, despite the fact that their impact is relatively small. In basic research, it is obvious that we are falling behind. Nevertheless, it holds the key to high technology. [Passage omitted]

III. Light Emitting Devices

Illumination technology is moving toward energy savings and high coloration. Cathode ray emission is being developed toward high resolution; graphics displays, and semiconductor light-emitting devices are being developed to meet needs in fiber-optic communications and optoelectronics. In display technology, thin-film electroluminescence (EL), plasma emission and liquid crystal display (LCD) are competing against each other. Hole-burning in non-uniform line widths has been used for [optical] storage. Zero-phonon lines in non-uniform line widths, ultrashort pulse techniques have been attempted for data processing.

Thin-film EL is better than the other two types of display in terms of viewing angle, brightness, contrast, and rate of response. Because LCD needs backlighting, its power requirement goes up and its cost increases. Although electroluminescence still consumes 2-3 times more energy than backlit LCD, its cost is getting closer.

Shanghai Institute of Metallurgy of the Chinese Academy of Sciences (CAS) has developed a series of semiconductor light-emitting devices. They have produced over a dozen devices and seven of them are used in production units. In the area of short-wavelength light-emitting devices, they have successfully developed a high-efficiency GaAs infrared LED (light emitting diode) with an external quantum efficiency of 4-6.3 percent; a $Ga_{1-x}Al_xAs/GaAs$ double-heterojunction (DH) LED with 50-150 μW of fiber end output, 12-20 MHz of frequency response, and 10^5 hours life; a high-speed, high-radiant-emittance GaAlAs/GaAs edge-emitting LED with 1-2 mW of output, and 100 MHz bandwidth; and an asymmetric-waveguide GaAlAs/GaAs fast edge-emitting LED with a maximum fiber end output of 220 μW and a cutoff frequency of 50-88 MHz. In the area of long-wavelength InGaAsP/InP devices, they have developed an InGaAsP/InP DH light-emitting device with a fiber end output of 40-50 μW at a 1.25-1.31-μm wavelength. They have also completed a 1.3-μm InGaAsP/InP edge- emitting LED and a 1.55-μm laser. In the 1970's, Zhejiang University developed $GaAs_{0.6}P_{0.4}/GaAs$ and GaP LEDs.

CAS's Changchun Institute of Physics has developed a variety of electroluminescent devices. In the 1960's, they successfully developed a signal display for use on submarines and an anti-research sighting device. Afterward, with improved techniques, they successfully developed an analog and digital display system for program control of a cupola furnace, a digital clock and a scoreboard. They also completed a multi-pixel (512x512) display screen for the [Chinese] Navy Submarine Command Center. In the 1980's, they developed several large color analog and digital displays, such as the 3 x 1 m^2 display at the food warehouse automatic control center and the 3 x 2.5 m^2 20 cd/m^2 [candelas per square meter] brightness display at the Great Hall of the People. Later, they used a plastic screen to raise its brightness to 80 cd/m^2. there are over a dozen plants capable of manufacturing ac powder-EL screens in China.

CAS's Changchun Institute of Physics has also developed dc powder-EL screens. In 1985, they provided a 1 m^2 matrix screen which was used at the Great Hall of the People. In 1986, they completed a microcomputer monitor screen which could display 1,000 characters and had a resolution of 1.5 lines-mm.

Shanghai Teachers' University has developed a flat dot-matrix television screen based on ac powder electroluminescence and built a large-screen color TV. They are working on a large character-matrix screen.

Hangzhou University conducted a study on low-energy electron luminescence and was able to raise [screen] saturated intensity from 5000 cd/m^2 to 72,800 cd/m^2. In addition, they are able to use cathode-ray emission in the so-called "dead-voltage range" (10^2-10^3 volts) to build a color screen with a brightness of 50,000 cd/m^2 and an efficiency of 12 lm/W [lumens per watt]. [Passage omitted]

Research on Space-Grown GaAs Monocrystals Noted at International Microgravity Conference

90CF0161A Beijing GUANGMING RIBAO in Chinese 5 Nov 89 p 1

[Article by correspondent Zhang Bingsheng [1728 3521 0581]: "Space-Grown Single Crystal GaAs Achieved in China"]

[Excerpts] At an international microgravity conference in July 1989, scientists were very interested in the paper entitled "Space-Grown GaAs Single Crystal and Its Properties" which was presented by Professor Lin Lanying [3829 5695 5391], committee member of the academic department of the Chinese Academy of Sciences. Foreign countries considered it an outstanding report; in view of China's situation, it is certainly an achievement that we should be proud of ourselves. [Passage omitted]

Professor Lin Lanying cannot forget a foreign expert's arrogant attitude expressed to Chinese researchers at an international microgravity meeting in August 1986. This

incident deeply hurt the feeling of this patriotic and ambitious female scientist. On her way back to China, she explored the feasibility of conducting materials-science research on one of China's recoverable satellites with Professor Da Daoan [6671 6670 1344], director of the Lanzhou Institute of Physics. Immediately after she got off the plane, she went to discuss her idea with Min Guirong [7036 2710 2837], director of the Research Institute of Space Technology, and with leaders of relevant organizations involved in the launch of the satellite, and received their enthusiastic support. The State Science Commission immediately provided 150,000 yuan for research after it learned about the project. Thus, China's first space materials experiment got started with a great deal of cooperation and encouragement behind it. Experts chose the topic of growing single-crystal GaAs in space.

This is a difficult subject. Because of energy and space limitations, the degree of difficulty was even higher. The melting point of GaAs is at 1238°C. Under the "harsh" conditions of 120 watts maximum allowable power for 90 minutes, it was not easy to ensure that temperature could go above 1240°C across a 4-cm-long melt zone. Considering other scientific experiments on the satellite, the outer case of the furnace could not exceed 40°C. Comrades in charge of developing the monocrystal furnace at the Lanzhou Institute of Physics worked very hard. They conducted 109 tests on the ground and repeatedly measured a variety of data in order to meet all the requirements. At the Institute of Semiconductors, the space materials research group also worked day and night to consider and calculate a series of scientific problems, including the characteristics, shape and size of the GaAs melt and an impact-resistant mounting scheme. After 7 months of hard work, shiny, torch-head-shaped GaAs monocrystals were successfully grown in space. These are China's first, and the world's first, space-grown GaAs single crystals. [See full report in JPRS-CST-89-001-L, 13 Jan 89, pp 82-95.]

On this basis, Chinese scientists conducted research on silicon-doped GaAs in 1988 and obtained even better GaAs single-crystal materials than the one made in 1987. Afterward, space-grown GaAs was used as the substrate of room-temperature continuously-coherent tunable lasers with power above 20 mW at the Institute of Semiconductors. This is quite an accomplishment. It has brought us into the scientific domain of microgravity in the study of space-grown semiconductors and devices—a realm heretofore dominated by developed nations—and has put us in a leading position.

Comparison of Foreign vs Domestic R&D of Surface-Acoustic-Wave Devices

90CF0161C Shanghai DIANZI YU ZIDONGHUA [ELECTRONICS AND AUTOMIZATION] in Chinese Vol 18 No 5, 20 Oct 89 pp 2-8

[Article by Wu Xiong [0702 3547] of the State-Run Xingguang [2502 0342] Electrotechnology Plant: "Production and Development Trends of Surface-Acoustic-Wave Devices in the World"]

[Excerpts] Abstract

This report describes the production and development trends of surface-acoustic-wave (SAW) devices in the world with emphasis on the development of filters, delay lines, resonators, oscillators and transducers, etc. Specific performance parameters of these devices are also given.

The surface-acoustic-wave (SAW) device is one of the three major solid-state microelectronic devices (i.e., very-large-scale integrated circuits, SAW devices and charge-coupled devices). There are numerous activities in SAW research and new effects are being discovered continuously. Many new SAW devices have been developed and are widely used in military electronic systems such as radar, guided missiles, communications (including satellite and fiber-optic communications), electronic countermeasures (ECM) and navigation, and commercial products such as radio and television broadcasting equipment. [Passage omitted]

I. Manufacturing and Development of SAW Devices in the World

1. Domestic Production and Development

Domestic development of SAW devices began in the 1970's. To date, there are over 40 research institutes, higher-learning institutions and plants involved in research of theory, design and production technique of SAW devices and in manufacturing SAW products. Close to 100 products have been developed for various applications. Design technology for linear SAW devices below 600 MHz is basically mature and linear devices below 100 MHz are already being manufactured in quantity. The output value of all domestically manufactured SAW devices and the associated materials is close to 100 million yuan per year. An annual production capacity of several tens of millions of TV intermediate-frequency (IF) filters has been created and more than ten million units are being manufactured per year. This product is valued at 50 million yuan yearly with more than 20 manufacturers involved. The SAW IF filter has become the most advanced component in domestically assembled color television sets. In addition to radio and TV broadcasting (including satellite broadcasting), from transmission, through relaying, to reception, SAW devices are used in communications systems such as satellite communications, digital microwave communications, mobile communications, optical communications, scatter communications, spread-spectrum communications, and secure communications. Furthermore, SAW devices are used in radar, electronic warfare and navigation devices. They include variuos SAW filters; fixed, dispersive and tapped delay lines; oscillators; convolvers; and resonators. Research has begun on developing SAW transducers and storage correlators and some prototypes are being built.

The operating frequency of domestically made SAW devices is under 500 MHz. Individual devices under

development may reach 1 GHz. A 70-MHz SAW convolution correlator has been developed. An SAW convolution correlator with storage capability is being developed. Reflection-grating devices are also under development. The time-bandwidth product of a dispersive delay line has reached 10^3 and the frequency of the delay line is less than 1 GHz. A 127-bit tapped delay line has been put into application and a 255-bit tapped delay line is under development. The line width of micromachined SAW devices under development is at the 2-μm level. The pattern covers an area of 110 x 15 mm with approximately 5000 lines. The ion etching technique has been established.

Compared to foreign countries, development and production of SAW devices in China is still lagging behind. this is primarily due to low operating frequency, incompleteness in product series, and outdated manufacturing techniques and equipment. Many new SAW devices cannot be manufactured. There is not enough effort to promote SAW devices. Many technical people in systems design do not fully understand the operating principle and potential applications of SAW devices; therefore, they cannot possibly introduce more new requirements. These devices have not yet been widely used in many applications. Some new technologies (such as acoustic charge-transfer devices, integrated SAW and semiconductor devices) have not yet been investigated by researchers. [Passage omitted]

II. Domestic and Foreign Manufacturing and Development of SAWF's

The SAWF (surface-acoustic-wave filter) is the most widely used SAW device in electronic products. Compared to the conventional L-C network, it has excellent amplitude-frequency and phase characteristics. Its electrical parameters are stable and reliable and it does not require any adjustment. Moreover, it is suitable for mass production. Basically, it uses single-crystal materials such as lithium niobate, lithium tantalate, bismuth silicate, piezoelectric ceramics, and piezoelectric zinc-oxide thin film. They all have their own advantages. These materials are widely used by different manufacturers in the world according to different product specifications and conditions. Like other filters, the SAWF is used to extract or suppress the signal at a specific frequency band. Structurally, it is a SAW interdigital transducer prepared on a piezoelectric crystal to achieve a wide bandwidth. Table 3 shows the performance level of SAWF's in the world. Each value is the highest level achievable for an individual item. It is impossible to simultaneously reach all these values in a particular device. Compromises will have to be made among several specifications.

Popularity of SAWF's is growing rapidly; every year tens of millions are being produced. New types of SAWF and production techniques are being introduced. The SAWF can be found in areas ranging from satellites and guided missiles to television sets at home.

Table 3. Performance Specifications of Domestic and Foreign SAWF's

	domestic level	foreign level
center frequency (MHz)	10 - 650	10 - 3000
maximum relative bandwidth	30 percent	40 percent
band suppression (dB)	40 - 50	45 - 80
amplitude ripple within band (dB)	0.1 - 0.5	0.2
typical insertion loss (dB)	10 - 20	2 - 20
squareness factor	1.1 - 3	1.1 - 3.0

1. Domestic SAWF Production and Development Trend

Some SAWF research and application items in China are close to or at world-class level. In particular, significant progress has been made in producing IF SAWF's for color TV use domestically. We are able to mass-produce them to replace imports. We are told that good progress has been made in research on high-frequency SAWF's. More than 20 models of SAWF's have been imported for use in domestically made color television sets, including SAWF's made from materials such as single-crystal lithium niobate (Hitachi), single-crystal tantalate (Toshiba, JVC, Sharp, Sony, NEC), piezoelectric zinc-oxide film (Matsushita), and piezoelectric ceramic (Sanyo). The special characteristics are that lithium niobate has a high electromechanical coupling coefficient, 7.3 times higher than that of lithium tantalate. Its parasitic false-signal level is one order of magnitude lower (less than 20 dB). The number of single-crystal wafers produced per kilogram of material is approximately 50 percent higher than that of lithium tantalate. Furthermore, production facilities and techniques are relatively easier to obtain. Lithium tantalate has better temperature characteristics than lithium niobate. Electrical parameters of the SAWF are not affected by thermal distortion. It also has high input and output impedance. Toshiba Corporation in Japan is using four-inch perfect lithium-tantalate substrates to fabricate SAWF's. However, this is more expensive and requires a higher production technique and more advanced equipment. SAWF's made of piezoelectric zinc-oxide thin film have low insertion loss, but it is very difficult to manufacture high-quality piezoelectric thin film in quantity. Even Matsushita does not use this type of SAWF in all its color TV sets. Piezoelectric ceramics are affected by factors such as mixing of raw materials and sintering technique. It is difficult to control porosity, homogeneity and repeatability in production. Therefore, the electrical performance of the SAWF in the Sanyo color TV is not as good as that of other SAWF's made of differentsubstrate materials. Lithium niobate is available in abundance in China. Therefore, the Hitachi version of SAWF was the first type to be manufactured domestically. Afterward, special SAWF's for color-TV use were developed to replace tantalate and ceramic with niobate. There are over 10 factories manufacturing a variety of

SAWF's for black and white and color TV sets, including the 26th Institute of the Ministry of Machine-Building & Electronics Industry, the State-Run Xingguang Electrotechnology Plant in Chengdu, the State-Run Jinghua Radio Equipment Plant in Jingdezhen and Zhuzhou Radio Plant No 7. Table 4 lists several popular domestically made Toshiba SAWF's and another Toshiba SAWF which was specifically developed for color TV sets for export only. The table also shows the corresponding Japanese SAWF models.

Table 4. Specifications of Domestically Made SAWF Used in Toshiba Color TV Sets

Item	UELBN38T04	UELBN38T02	(PAL/B.G)	(PAL/I)	(NTSC/M)
			LBN38T01	LBN39.501	LBN45.75T01
picture carrier frequency level (Db)	-4.5 plus or minus 1.5	-5 plus or minus 1.5	5 plus or minus 1.5	4 plus or minus 1.5	5 plus or minus 1.5
color carrier frequency level (dB)	-3 plus or minus 1.5	-4 plus or minus 1.5	4 plus or minus 1.5	3.5 plus or minus 1.5	5 plus or minus 1.5
sound carrier frequency level (dB)	-16 plus or minus 2	-20 plus or minus 2	20 plus or minus 2	15 plus or minus 2	17 plus or minus 3
adjacent-channel picture suppression level (dB)	more than or equal to 40	more than or equal to 40	more than or equal to 40	more than or equal to 40	more than or equal to 40
adjacent-channel sound suppression level (dB)	more than or equal to 40	more than or equal to 40	more than or equal to 40	more than or equal to 40	more than or equal to 40
low-end out-band suppression (dB)	more than or equal to 30	more than or equal to 30	more than or equal to 30	more than or equal to 30	more than or equal to 30
high-end out-band suppression (dB)	more than or equal to 30	more than or equal to 30	more than or equal to 30	more than or equal to 30	more than or equal to 30
ripple within band (dB)	<0.5	<0.5	<0.5	<0.5	<0.5
group delay fluctuation within band (ns)	<100	<100	<100	<100	<100
input capacitance (1MHz) (pF)	11 plus or minus 2	12 plus or minus 2.5			
output capacitance (1MHz) (pF)	8 plus or minus 2	9 plus or minus 2			
insertion loss (dB)	38 plus or minus 3	38 plus or minus 3	36 plus or minus 3	36 plus or minus 3	30 plus or minus 2
corresponding Japanese SAWF model number	F1036E	F1036C	F1034	F1035	F1032B
	F1036EM	F1026V			
	COL30CE				

Most domestically made TV IF SAWF's are in the TO-8 metal can package. For the moment they are not available in the small flat plastic package that is widely used by most manufacturers such as Toshiba, Matsushita, Philips and Thomson in Japan and European countries. To facilitate welding, the base lead has to be gold-plated, which increases the cost of the SAWF. Hence, it is especially important to change to commercial SAWF packages. This is the key factor determining the selling price of the product.

We have also developed a number of SAWF devices such as an IF SAWF for use in a broadcast-TV frequency translator, a residual-sideband SAWF in a decimeter-wave television transmitter, a 10.7-MHz SAWF in an FM radio receiver, a 360-MHz bandpass SAWF, a 140-MHz SAWF for use in a direct-broadcast satellite [DBS] television receiver, 70-MHz and 17.5-MHz and 20-MHz SAWF's for use in satcom ground stations, 136-MHz and 167-MHz SAWF's for use in fiber-optic communications, a 138.49-MHz SAWF for use in mobile communications, and SAWF's for radar and ECM equipment in military and space applications. They all work very well in the field. Some products are available commercially. Table 5 shows a comparison of performance of domestic and foreign-made residual-sideband SAWF's for use in a decimeter-wave TV transmitter.

Table 5. Performance of Domestic and Foreign-Made Residual Sideband SAWF's

performance	domestic	Toshiba, Japan
	LXMSG-3	F1343
picture carrier frequency (MHz)	37	38.9
bandwidth per dB (MHz)	31 - 37.75	34.7 - 39.65
ripple within band (dB)	0.5	plus or minus 0.2
group delay fluctuation (ns)	< plus or minus 30	plus or minus 30
insertion loss (dB)	<30	35

Although the SAWF has matured in China, there are still many factors limiting it from entering new areas of applications. The major development objectives are: (1) We must further reduce SAWF insertion loss to under 1 dB in order to suit the new development trend. Furthermore, its power must be raised (to 10 W). It must operate without three-phase matching and be tunable. (2) We have to improve its package. (3) The operating frequency of the SAWF has to be raised. (4) The SAWF has to be programmable. In summary, better material quality and improved design and manufacturing technique will help the domestic SAWF industry grow. [Passage omitted]

III. Production and Development Status of Other SAW Devices in China and Abroad

1. SAW Delay Lines

An SAW propagates on the surface of a solid. It is tappable and controllable. Furthermore, the speed of an SAW is only l/500,000th that of an electromagnetic wave, hence it can be used to make a variety of very compact delay lines including fixed, variable, dispersive and tapped types. SAW dispersive delay lines are used in radars, computers, communications systems and survey instruments. They can significantly improve the resolution and effective range of the radar. Domestically, we have developed and manufactured a 40->ms dispersive delay line, a 200-MHz-bandwidth delay line, and a 127-bit tapped delay line. 0.2-μs, 0.4-μs, 0.8-μs, 1.6-μs, 2.4-μs and 4.8-μs fixed delay lines are being used in a mobile communications analog test instrument under development at the Ministry of Electronics Industry.

In other countries, Rohm Aerospace Development Center in the United States has developed a 1.5-GHz delay line based on GaAs. The U.S. Army Harry Diamond Laboratory improved the manufacturing technique for a 4-GHz-bandwidth inductive matching monolithic SAW delay line and raised its yield to 50 percent. Anderson Laboratory in the Unites States manufactures a 500-MHz-bandwidth SAW dispersive delay line to be used in digital communications and radar. Sotech Company has developed a series of new SAW delay lines in 1987: when the central frequency is below 20-600 MHz, they have a 20-200-μs-long non-dispersive delay; relative bandwidth is 4-30 percent that of the central frequency and the insertion loss is 20-50 dB; amplitude ripple is 0.5-1.5 dB; false-response suppression is better than 25 dB; and the delay time of the American-made SAW delay lines is 100 ns-100 μs (at 10-1000 MHz). Hitachi Central Research Institute has developed an adjustable SAW delay line which has an electrically controlled air gap. Northeastern University in Japan has developed a zero-temperature-coefficient $A1N/A1_20_3$ SAW delay line. Delay lines have a wide range of applications: they can be used to develop other types of SAW devices, such as an SAW oscillator.

2. SAW Oscillators (SAWR)

An SAWR is a frequency-controlling element based on an SAW delay line or SAW resonator. The SAWR technical specifications are close to those of a crystal oscillator, but it has a higher oscillation frequency and wider voltage-control range. Therefore, it is more suited for a voltage-controlled or frequency-modulated oscillator to be used in areas such as radar, navigation, fiber-optic communications, satellite communications, remote-control and telemetry, and instrumentation. Table 8 shows a comparison of performance characteristics of domestic and foreign SAWR's.

Table 8. Comparison of Domestic and Foreign SAWR's

type	single-sideband phase noise (dBc/Hz)		short-term frequency stability σy(Is)	Q.F.10^{-13}	operating frequency (MHz)
	100 Hz	1 kHz			
Foreign					
SAWDL	-87		30 x 10^{-10}	0.12	401
SAWR	-107			0.24	311
SAWDL	-65		3 x 10^{-9}	0.06	300
SAWR	-91		2 x 10^{-10}	0.15-0.30	300
SAWDL	-72		5 x 10^{-10}	0.28	1400
SAWR			5 x 10^{-11}	0.77	160
Domestic					
SAWDL	-87	-119	3.3 x 10^{-13}	0.44	400
SAWDL		-103	1.1 x 10^{-9}	0.28	560
SAWR	-62	-108	5.5 x 10^{-10}	1	500
SAWR		-103.8	app. 10^{-10}	0.33	435

We have also developed the Model ZMSL-5 560-MHz SAWR, which uses an SAW delay line as the frequency-controlling element. It consists of a frequency-selection circuit, a loop amplifier and an output-amplifier buffer. It is primarily used to reduce the number of frequency-multiplication steps in a radar in order to simplify the

circuit and improve the overall performance. In addition, it can also be used as a solid-state microwave frequency source in communications and ECM systems. The SAWR has not yet been widely used in China, but it is being investigated.

The operating frequency of foreign-made SAWR's exceeds 5 GHz. This represents a breakthrough in the development of the technology. Furthermore, a great deal of progress has been made in practical usage and commercialization of the product. In England, the Plessey Company is selling SAWR's at $600 apiece. A variety of SAWR products are also available from Philips Research Institute, the Marconi Company, MEC in the United States and Thomson Company in France. Their operating frequency ranges from 300 to 1500 MHz and the output level is +10dB. Anderson Laboratory in the United States has developed a series of SAWF's operating at 1.2 to 2.4 GHz; for use in identification friend or foe [IFF] equipment and tactical air-force navigation systems, it has perfected 1030/1090-MHz SAWR's. In addition, the SAWR is used abroad as a radio-frequency (rf) vibrator in rf modulators and channel converters used in VCR's and TV systems. McMaster University in the United States has a tunable SAWR. Tektronix Corporation has developed the 812-0005-01/02/03 SAWR model series which operates below the 500-MHz standard frequency limit and weighs 3.5 g. The SAWR used in the VCR manufactured by Toshiba reduces the volume of the original oscillator by approximately 35 percent. In instrumentation, the SAWR is being used in the HP8558 and HP8568 frequency spectrum analyzers. The air-defense and space-systems research group at TRW has combined RF-LSI technology with SAW technology and developed a frequency synthesizer with direct [frequency] mixing and frequency-division capability.

Further research is being conducted worldwide on the design, technology, production technique, new materials and novel modes associated with SAWR's. The SAWR will be in mass production in the near future.

3. SAW Storage Correlators/Convolvers

The correlation signal and convolution signal of two electronic signals are obtained in real time with an SAW storage correlator and a convolver, respectively, by using the non-linearity of the SAW. These devices are adaptable to any input signal. There are numerous SAW storage correlator/convolver development programs abroad, including those for the air-gap type, strip-coupling type, monolithic type, etc. Some prototypes are available for trial use. This type of device is ideal for signal processing; for certain applications, it is comparable to a complex digital processor. Siemens Research Laboratory has completed trial manufacture of an SAW convolver for communications use with a central frequency of 300 MHz. In China, we have developed a monolithic SAW convolver/correlator; its convolution efficiency is -63 to -65 dBm, with a 40-dB dynamic range and a 4.5-μs response time.

4. SAW/CCD Devices

When combining an SAW with semiconductor technology, it is possible to utilize the wide bandwidth of the SAW device in conjunction with the long and flexible time-processing capability of the CCD (charge-coupled device). Since its invention of the CCD in 1970, Bell Labs in the United States has introduced the SAW/CCD technology, and has developed a number of structures to date. Unique devices capable of processing several types of analog signal, such as an SAW/CCD buffer storage device, correlator, and programmable matched filter, have been developed. These devices can be used to sample and store over 66 return waves in high-speed radar Doppler processing to calculate the target range, with fast-input and slow-output capability; they have great potential in sonar applications as well. Currently, they are primarily used in military applications, where a great deal of effort is being expended in foreign countries. The advantage of SAW/CCD technology is its capability to transfer input acoustic, optical or electrical signals in an analog manner. Furthermore, these devices have high information density, high speed, low charge-transport loss, and excellent homogeneity. They are capable of performing bandwidth analog signal processing with up to 1,000 discrete samples. In addition, they are programmable, have a wide input bandwidth and a slow output or reference-data rate, and are very compact. SAW/CCD devices are far more complicated than either the SAW or the CCD by itself, in theory and practice. SAW technology will have to rely on semiconductor technology to reach a higher level in the future.

5. SAW Transducers/Sensors

Based on its design flexibility and unique digital-output capability, the SAW has found a new area of applications in sensing technology and non-destructive testing. Many SAW temperature, force, pressure, gas, voltage, power, and acceleration sensors have been introduced at an amazingly fast pace. Compared to ceramic and semiconductor-based sensors, SAW sensors have higher sensitivity, better selectivity, higher frequency, lighter weight and are easier to install. The development of SAW sensors has just began in China. It is absolutely necessary to accelerate the basic and applied research on various SAW sensors based on existing research and production resources for SAW devices.

In conclusion, SAW devices are being actively studied and manufactured all over the world. Relevant new technologies will emerge continuously. It is expected that some areas in the electronic industry will leap forward as SAW devices are widely adopted. (References omitted.)

Bi-Pb-Sr-Ca-Cu-O-Based 107K Single-Phase Superconductors

Pressure Effects

90CF0159 Beijing KEXUE TONGBAO in Chinese Vol 34 No 18, 16-30 Sep 89 pp 1383-1386 [MS received 25 Mar 89]

[Article by Zhang Jinlong [1728 6651 7893], Cui Changgeng [1508 7022 1649], Li Shanlin [2621 1472 2651], and Li Jun [2621 6511] of the Institute of Physics of the Chinese Academy of Sciences, and Shi Fan [0670 0416] and Shi Zhenhua [0670 2182 5478] of the Department of Materials Science and Engineering of Beijing University of Science and Technology: "Study of Pressure Effects on Bi-(Pb)-Sr-Ca-Cu-O-Based 107K Single-Phase Superconductor"]

[Text] Key words: single-phase superconductor, pressure effects, lattice perfection, Cu-O layer, resistance jump.

I. Introduction

Since Michel et al.[1] discovered a series of Bi-based superconductors, there has been continual interest in investigating the high-T_c [critical temperature] and single-phase nature of the system. After the discovery of a 105 K superconducting phase in the multi-phase Bi-Sr-Ca-Cu-O system by Maeda et al.,[2] the zero-resistance temperature of the Pb-doped Bi-based multi-phase system has reached 110 K.[3] The single-phase issue has both physical and applied significance. On this premise, a single-phase superconductor Bi-(Pb)-Sr-Ca-Cu-O was prepared by sintering Pb-doped and Ca- and Cu-enriched $Bi_2Sr_2Ca_2Cu_3O_y$. Immediately afterward, we conducted a series of performance analyses. This paper reports the material's superconducting behavior under pressure. It is compared with the result of another phase of Bi-Sr-Ca-Cu-O with a low T_c in an attempt to elucidate the mechanism for high-temperature superconductivity.

II. Experimental

1. Preparation of Single-Phase Specimen

A solid-reaction synthesis method was used. A fully mixed reagent-grade powder of PbO, Bi_2O_3, $SrCO_3$, $CaCO_3$ and CuO in atomic ratio of Pb:Bi:Sr:Ca:Cu = 0.3:1.7:2:3:4 was pre-heated at 800-810°C for 12 hours, re-mixed, pressed into a pellet, and then sintered in air for 60 hours at 870-880°C. It was cooled inside the furnace to 500°C and then taken out of the furnace and allowed to cool naturally to room temperature. Finally, it was sintered at 880°C for 180 hours. The specimen thus obtained was confirmed to be a single-phase superconductor by electromagnetic measurement, X-ray diffraction and TEM [transmission electron microscopy] and determined to have an orthogonal lattice. The lattice parameters are a = 5.418 Angstroms, b = 5.346 Angstroms, and c = 37.10 Angstroms.[4]

2. Electromagnetic Measurement

Resistance was measured by the standard four-lead method with a potential resolution of 2×10^{-8} V. A mutual-inductance method was used to determine its ac magnetic susceptibility. The reference frequency was 220 Hz and the sensitivity of the PAR [Princeton Applied Research] phase-lock amplifier was 2×10^{-8} V. Temperature was measured with a calibrated Cu resistance thermometer with an accuracy of +/- 0.1 K.

3. Generation, Locking and Measurement of Pressure

The specimen, with four leads attached, was placed inside a Be-Cu pressure container. The pressure container was a cylinder with a piston. The pressure medium was a 1:1 mixture of kerosene and diffusion-pump oil which generates an isotropic static hydraulic pressure. Pressure was varied at room temperature and was maintained constant with a locking screw. Pressure was standardized with Pb.

III. Results and Discussion

Figure 1 shows the resistance and diamagnetic transition curves for Bi-(Pb)-Sr-Ca-Cu-O. Zero resistance and diamagnetic transition occurred at 107.4 K and 107.0 K, respectively. Moreover, there is only one superconducting transition. No other transition was found at magnetic-field [flux density] as high as 7T [tesla].

Figure 2 shows the dependence of superconducting transition temperature of the Bi(Pb) system upon pressure. Except $T_{c,90\%}$, other characteristic temperatures are raised with increasing pressure. With the exception that $T_{c,onset}$ is slightly off because of its arbitrary nature, $T_{c,m}$ and $T_{c,0}$ essentially increase at the same rate, at approximately 0.7 K/GPa [gigapascal]. Changes in $T_{c,90\%}$ and

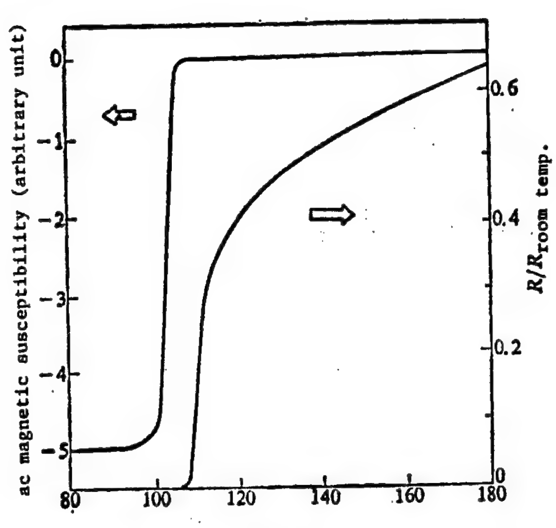

Figure 1. Transition Curves of Resistance and Diamagnetism for Bi-(Pb)-Sr-Ca-Cu-O

$T_{c,10\%}$ indicate that the transition width is getting narrower. This leads us to believe that the perfectness or orderliness of the lattice is improved under some pressure which is associated with the increase in thermodynamic orderliness, i.e., decrease in entropy. (There are more reasons to believe it happens in a material with numerous lattice defects.) The total entropy of the superconducting phase is less than that of the normal phase; therefore, thermodynamically speaking, pressure facilitates the transition from a normal to a superconducting phase.

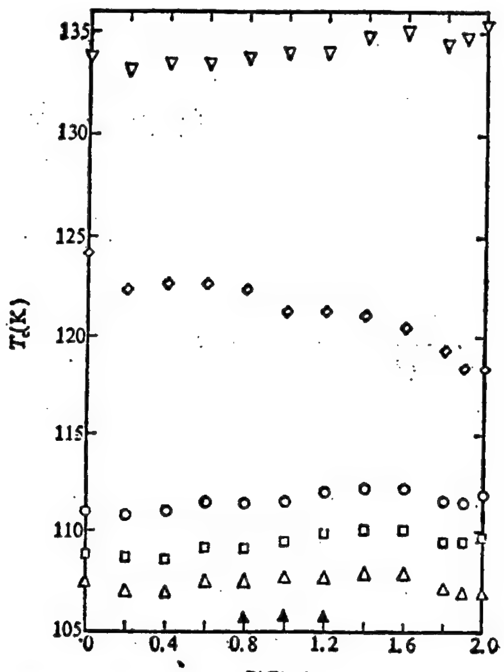

Figure 2. Superconducting Transition Temperature at Bi-(Pb)-Sr-Ca-Cu-O Versus Pressure

Key: Upside down triangle—onset of transition ($T_{c,onset}$); diamond—at 90 percent residual resistance ($T_{c,90\%}$); circle—transition mid-point ($T_{c,m}$); square—at 10 percent residual resistance ($T_{c,10\%}$); triangle—zero-resistance temperature ($T_{c,0}$)

Below 0.4 GPa, the situation is somewhat abnormal. However, it does not seem to reflect the intrinsic characteristics of the specimen. This is because the specimen tested is relatively porous. It was affected by factors other than the static hydraulic pressure, especially during the beginning. The lattice was not so perfect to start with and weakly linked grains might be destroyed to some extent, causing T_c to go down. In addition, T_c dropped steeply when the pressure was raised to 1.8 GPa. The data points obtained during the pressurizing cycle do not agree with those obtained in the depressurizing cycle, indicating permanent damage to the specimen. Therefore, we believe that only results obtained between 0.5 GPa and 1.7 GPa are real.

The value of $dT_c/dP = 0.7$ K/GPa for the Bi(Pb) system is very small among oxide superconductors. In comparison, the value $dT_{c,0}/dP = 2.75$ K/GPa of the lower-T_c superconducting phase of Bi-Sr-Ca-Cu-O we obtained earlier is much larger.[5] This phenomenon is considered from three aspects.

(1) Pressure effects get larger when the lattice is less perfect (which usually happens in low-T_c superconducting oxides). The single-phase nature and lattice perfection of the Bi(Pb)-based system are better than those of the Bi-based system.

(2) The atomic radius of Pb (175 pm) is larger than that of Bi (155 pm). The effect of using Pb to replace Bi is equivalent to "chemical decompression" and ought to magnify the pressure effects of the Bi(Pb)-based system. However, this does not appear to hold in reality. This suggests that "chemical decompression"[6] does not apply here.

(3) The Bi-based system and Bi(Pb)-based system have the so-called "2212" and "2223" superconducting phases, respectively. Their primary differences are that the c-axis lengths of the unit cells differ by 6 Angstroms and the numbers of Cu-O layers are not identical, as shown in Figure 3. The two Cu-O layers in the "2212" cell are farther apart; the "2223" cell has two extra Cu-O layers and the distance between layers is smaller. It is reasonable to have a larger pressure effect when the Cu-O layers are farther apart since they play a key role in superconductivity. It is further speculated that the coupling of Cu-O layers is critical to superconductivity in high-T_c oxides.

We noticed that at normal pressure the resistance transition curve of the Bi(Pb)-based system is essentially a straight line from its normal state to the origin of the coordinate (0K, 0Ω). This suggests that the primary source of resistance in the high-temperature region above T_c is lattice scattering. Then, raising pressure to

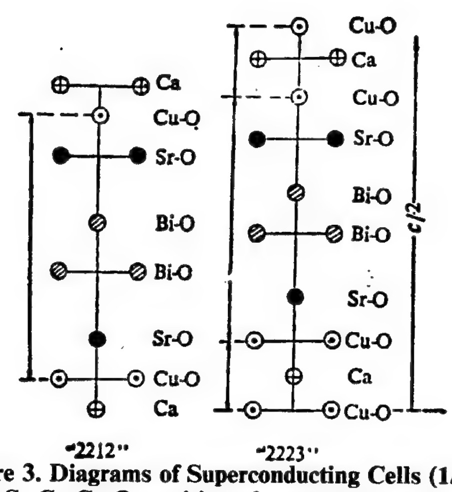

Figure 3. Diagrams of Superconducting Cells (1/2) of Bi-Sr-Ca-Cu-O; position of o atoms not marked.

increase the orderliness of the lattice should lower the resistance in the normal state. This was found to be true, as shown in Figure 4. Nevertheless, we found a slight sudden increase in resistance at near 1.0 GPa. This corresponds to an abrupt change of the ratio of normal to residual resistance. Similar effects were observed in other systems with high T_c. For example, reference 7 reported that the jump in normal-state resistance there slowed down as T_c was increased. The authors are attributing this phenomenon to changes in some fine structure associated with the Cu-O layer. In the Bi(Pb)-based system, despite the fact that it is not obvious that the increase in T_c in the vicinity of 1.0 GPa is slowing down because dT_c/dP is small, resistance abnormality nevertheless is still apparent. Therefore, there may be similar fine structural changes at near 1.0 GPa.

IV. Conclusion

A single-phase 107 K Bi-(Pb)-Sr-Ca-Cu-O superconductor was prepared by solid-state reaction. The effects of pressure on its superconductivity were investigated and we found that $dT_c/dP = 0.7$ K/GPa. Compared to the results obtained with Bi-Sr-Ca-Cu-O, it was found that lattice perfection and Cu-O layer distance are pressure-sensitive. In addition, a normal-state resistance jump was found near 1.0 GPa. It was believed to be associated with some fine structural changes related to the Cu-O layer.

Acknowledgement: The authors wish to thank Mr Huang Xinming [7806 2450 2494] for his assistance in the experiment.

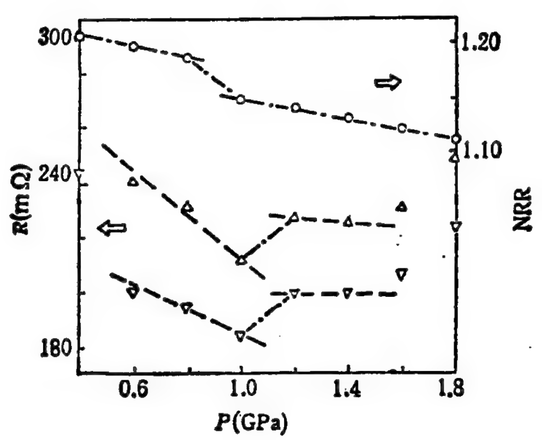

Figure 4. Normal Resistance (at 170 K, -triangle) and Residual Resistance (-upside down triangle) and Their Ratio NRR (normal-residual ratio of resistance, -circle) Versus Pressure. Only 0.4-1.8 GPa is shown because of the reason given earlier.

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Crystallographic Data, X-Ray Powder Diffractometry Graphs

90CF0159 Beijing KEXUE TONGBAO in Chinese Vol 34 No 18, 16-30 Sep 89 pp 1412-1414 [MS received 14 Feb 89]

[Article by Shi Nicheng [2457 0242 2110] of China Geological University, Shi Fan [0670 0416] of Beijing University of Science and Technology, Ma Zhesheng [7456 0811 3932], Wang Xuefang [3076 7185 5364] of China Geological University, Rong Tiesheng [1369 6993 3932], Du Jian [2629 0256] and Zhou Shouzeng [0719 1108 2582] of Beijing University of Science and Technology: "Crystallographic Data and X-Ray Powder Diffractometry Patterns of the 107 K Single-Phase Pb-Bi-Sr-Ca-Cu-O-Based Superconductor"]

[Text] Key words: Pb-Bi-Sr-Ca-Cu-O single-phase superconductor, crystallographic data, powder pattern.

Maeda et al. found two superconducting phases (85 K and 105 K) in the Bi-Sr-Ca-Cu-O system.[1] In these compounds, substitution with Pb was found to improve the superconductivity and structural stability.[2,3] Recently, Shi Fan et al. successfully prepared a 107 K single-phase superconductor with a nominal structure of $(Pb, Bi)_2 Sr_2Ca_3Cu_4O_y$ by sintering at 870-880°C over a long period of time.[4] This paper is limited to the determination of the crystallographic parameters of this single-phase material by X-ray powder diffractometry.

The single-phase nature of this 107 K superconducting substance has been verified by its powder X-ray diffraction pattern. This is due to the disappearance of the diffraction peaks corresponding to the low-T_c phase and the semiconducting phase, i.e., peaks with 2θ equal to 5.7° and 7.2° (CuKα), respectively. Initial X-ray crystallographic study indicated that the powder pattern could be expressed by an orthogonal cell (a = 5.32 Angstroms, b = 5.42 Angstroms, c = 37.1 Angstroms). However, Rong Tiesheng et al. found that the point group mm 2 observed in their focused-beam electron diffraction study was destroyed due to the disappearance of a symmetry plane. Its symmetry was reduced to a monoclinic system. At the same time, a modulation structure with and without a common scale was discovered.[5]

Although the modulation structure has been detected by electron diffraction, X-ray crystallographic experiments show that most diffraction peaks are due to primary diffraction. Hence, the indexing of the X-ray powder-diffraction pattern was performed on the subcell of electron diffraction.

Based on electron diffraction and X-ray crystallography, there may be three possible sets of subcells. The first is an F-face-centered lattice with a cell of a = 5.32 Angstroms, b = 5.42 Angstroms, c = 37.1 Angstroms and γ approximately equal to 90°. The second is a B-face-centered lattice with a = 5.32 Angstroms, b = 3.83 Angstroms, c = 37.1 Angstroms and γ approximately equal to 135°. The third is an I-body-centered lattice with a = 3.78 Angstroms, b = 3.83 Angstroms, c = 37.1 Angstroms and γ approximately equal to 90°. Their orientations and transformation relations are shown in Figure 1. Based on the definition of reduced cell as given by Dannay, Ondik and Burzlaff, we believe the third orientation is more probable. This is because the basic vectors a and b are the two shortest ones perpendicular to c and the angle γ is not a sharp angle and is close to 90°. Furthermore, selecting the third orientation also makes it easy to compare with other perovskite-type superconductors such as the Y-Ba-Cu-O and Bi-Sr-Ca-Cu-O-based systems.

A powder X-ray diffraction experiment was carried out with a Model D_{max}/RC rotating-target X-ray powder diffractometer made by Nihon Rigaku Denki. [Experimental parameters were:] CuKα, 50 kV, 110 mA, SCAN SPEED 1°/min, STEP/SAMP 0.02°, threshold width 0.06°, slit DS, 1 mm; RS, 0.05 mm; SS, 1 mm; scanning range 3°-70° (2θ). The X-ray powder diffraction pattern is shown in Figure 2.

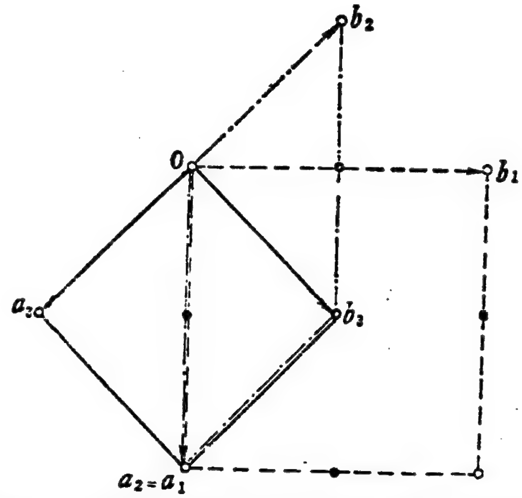

Figure 1. Selection of Three Cells and Their Transformation Relation; circle represents 0 height and dot represents ½ height.

The least-squares correction of the diffraction-pattern index and the cell parameters is done with the APELEMNENT (No. 9214) program. The calculated and observed

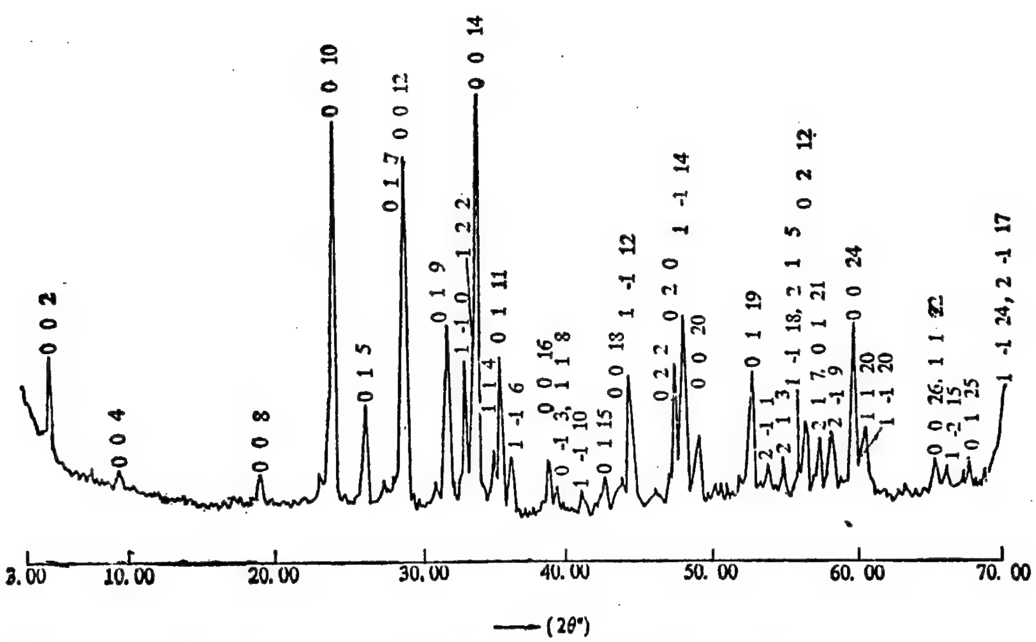

Figure 2. X-Ray Powder Diffraction Pattern of (Pb, Bi)$_2$ Sr$_2$Ca$_2$Cu$_3$O$_y$ (CuK); reflection is labeled as a monoclinic system and angles specified are 2°.

values of the index (h, k, l) and d are shown in Table 1. The corrected cell parameters are:

a = 3.779(2) Angstroms, b = 3.834(1) Angstroms, c = 37.150(7) Angstroms, $\gamma = 90°51(2)'$ (c-axis is the unique axis), and V = 538.1(2) Angstroms^3. After taking electron diffraction into consideration, the space group should be I112. The calculated and observed values of d are quite consistent. In the X-ray powder diffraction graphs, the (00l) diffraction often occurs; this can be explained by the fact that this crystal has intense layer-structure characteristics. It is significant that the (0014) diffraction is a super-intense diffraction. This is probably because most heavy atoms are located on that plane. The relation between modulation structure and the X-ray diffraction pattern is yet to be further studied.

Table 1. X-Ray Powder Diffraction Data on $(Pb, Bi)_2 Sr_2Ca_2Cu_3O_y$ (a = 3.779 Angstroms, b = 3.834 Angstroms, c = 37.150 Angstroms, $\gamma = 90°51'$, h + k + l = 2n)

h	k	l	d(calc)Angstroms	d(obs)Angstroms	Cukα		2θ
0	0	2	18.562	18.628	4.740	45	-0.004
0	0	4	9.281	9.301	9.500	19	-0.078
0	0	8	4.641	4.648	19.080	20	-0.036
0	0	10	3.712	3.717	23.920	95	-0.016
0	1	5	3.406	3.401	26.140	33	-0.044
0	1	7	3.107	3.108	28.740	69	0.005
0	0	12	3.093	3.095	28.820	85	-0.016
0	1	9	2.808	2.810	31.820	51	0.017
1	-1	0	2.709	2.712	33.000	43	0.042
1	2	2	2.678	2.676	33.480	22	0.020
0	0	14	2.652	2.653	33.760	100	0.007
1	1	4	2.563	2.563	34.960	24	0.016
0	1	11	2.534	2.535	35.380	44	0.021
1	-1	6	2.481	2.481	36.180	19	-0.005
0	0	16	2.321	2.324	38.720	22	0.054
1	1	8	2.312	2.290	39.320	17	-0.010
0	-1	13	2.291				
1	-1	10	2.190	2.191	41.160	16	-0.040
0	0	18	2.063	2.063	43.840	19	-0.009
1	-1	12	2.040	2.039	44.380	40	-0.003
0	2	0	1.916	1.915	47.440	44	-0.048
0	2	2	1.907	1.908	47.620	24	0.034
1	-1	14	1.895	1.896	47.940	54	0.024
0	0	20	1.857	1.857	49.020	28	0.008
0	1	19	1.741	1.740	52.560	40	-0.011
2	-1	1	1.703	1.703	53.800	21	-0.001
2	1	3	1.669	1.669	54.980	23	-0.080
1	-1	18	1.642	1.641	56.000	22	-0.007
2	1	5	1.640				
0	2	12	1.630	1.630	56.400	31	-0.040
2	1	7	1.606	1.605	57.360	27	-0.027
0	1	21	1.606				
2	-1	9	1.576	1.579	58.390	27	0.139
0	2	14	1.554	1.552	59.520	29	0.077
0	0	24	1.547	1.547	59.740	51	-0.039
1	-1	20	1.532	1.531	60.360	25	0.045
1	1	20	1.525	1.526	60.630	27	0.042

Table 1. X-Ray Powder Diffraction Data on $(Pb, Bi)_2 Sr_2Ca_2Cu_3O_y$ (a = 3.779 Angstroms, b = 3.834 Angstroms, c = 37.150 Angstroms, γ = 90°51', h + k + l = 2n) (Continued)

h	k	l	d(calc)Angstroms	d(obs)Angstroms	Cukα		2θ
0	0	26	1.428	1.426	65.380	21	-0.009
1	1	22	1.426				
1	-2	15	1.412	1.411	66.160	20	-0.064
0	1	25	1.386	1.386	67.600	19	0.053
1	-1	24	1.343	1.343	69.980	30	-0.017

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Research in Controlled Nuclear Fusion Reported

Background on "Magic Light" Laser Apparatus

90CF0169 Beijing GUANGMING RIBAO in Chinese 20 Sep 89 p 2

[Text] Located in the Shanghai Institute of Optics and Fine Mechanics (SIOFM) in suburban Shanghai is China's highest-power laser device. Within 10^{-10} to 10^{-9} second, the twin-beam laser output can reach a power of 10^{12} watts. When the beam is focused onto the material surface, it can generate temperatures over 10 million degrees and strong shock waves and recoil pressure. There are only seven or eight such high-power lasers in the world.

The development of high-power lasers is one of the principal approaches for achieving inertial-confinement fusion, which can fundamentally solve the energy problem of mankind. It is also an important experimental tool in the study of X-ray lasers and nuclear-explosion simulation. High-power lasers may also be used in other leading-edge research and have significant importance in economy, defense and science and technology.

The "Magic Light" is a large interdisciplinary science and engineering project. The system consists of 14 subsystems including the laser, the target range, the laser parameter-measurement subsystem, the power supply, the central control and the laboratory environmental engineering. The system has more than 80 precision instruments and touches upon such technical fields as laser, optics, fine mechanics, optical materials, electronics, micromachine technology, and ultra-clearn technology. The "Magic Light" utilizes 15 new materials, technologies, structures, and methods that are used for the first time in China. More than half of the new materials and technologies are world-class and some are unique. For example, an adaptive optical-wavefront correction system was used in such a high-power solid-state laser for the first time. Uniform illumination of the target surface was achieved by a lens array, a method dubbed by colleagues as the "Shanghai method."

The success of the "Magic Light" is a remarkable achievement in China's development of laser technology. It marks an elevation of China's high-power laser research to the world class, and shows that China is among the few nations with such integrated manufacture capability. Even more encouraging is that this advanced device is made in China, by middle-aged and young scientists and technical people trained in China.

Successful Inertial Confinement With "Magic Light" Apparatus

90CF0169 Beijing RENMIN RIBAO in Chinese 26 Nov 89 p 1

[Article by Zhang Xuequan [1728 1331 0341] and Wu Yingxi [0702 5391 3556]]

[Text] Shanghai, 25 Nov (XINHUA)—An inertial-confinement laser fusion experiment recently carried out with a Chinese-made high-power laser device has resulted in a major advance.

The laser device, called the "Magic Light," has an output of 2 billion kilowatts [or 2 terawatts]. Using this high-power laser to conduct an integrated physical experiment of inertial-confinement fusion, Chinese nuclear physicists, chemists and laser experts successfully aimed the dual-beam laser at the perforated-cavity target. The radiation temperature achieved in the cavity exceeded that in the same type of foreign experiment using similar devices. According to the researchers, the attainment of the high radiation temperature in the cavity is a good foundation for the next step, where radiation-driven generation of neutrons is the goal.

Inertial-confinement fusion is also called laser-induced fusion. Researchers explained that the success of this experiment is an encouraging advance in mankind's pursuit of inexhaustible energy from nuclear fusion.

The "Magic Light" is a large laser device built by a Chinese technical staff two years ago in Shanghai. All its parts and materials are made in China. Since it began operation two years ago, a number of experiments have been conducted. Its technical performance has reached the advanced level of similar foreign units.

Fifth Anniversary of Safe Operation of HL-1 Tokamak

90CF0169 Beijing RENMIN RIBAO in Chinese 25 Oct 89 Overseas Ed. p 4

[Article by Quan Nengsen [0356 5174 2773]]

[Excerpt] China's largest controlled nuclear fusion experimental device, the HL-1 Tokamak, just had its fifth anniversary of safe operation. The HL-1 has made major contributions to the exploration of controlled fusion conditions and to the search for the ideal energy source for mankind.

Since the HL-1 was put into operation, the Southwest Physics Institute of China's nuclear industry has conducted 16 major joint experimental projects with the device and obtained 349 experimental results, including 52 award-winning items. High experimental parameters and targets have been achieved in the experiments. For example, the magnetic field strength has reached 34,000 Gauss, the plasma current has reached 220 kA, the electron temperature has reached 18 million degrees, the plasma density has reached 7×10^{13}-9×10^{13} per cubic centimeter, the plasma sustaining time has reached 1,600 milliseconds, and the energy confinement time is about 25 milliseconds. These parameters and specifications are at the forefront in China and rank among the first 18 places in the world. The sustaining time of the plasma is unusual among similar devices in the world.

The HL-1 Tokamak was designed, manufactured and installed by the Chinese. It started operation in September 1984. In 1987 it was awarded the first prize by the state for science and technology advances. The results obtained in experimental research with the HL-1 for Chinese and foreign scientists have received good review among international experts. Satisfactory results were also obtained in two important research projects commissioned by the International Atomic Energy Agency. [Passage omitted]

Interview with Scientist on Use of Lasers, Particle Beams

90CF0169 Beijing KEJI RIBAO [SCIENCE AND TECHNOLOGY DAILY] in Chinese 9 Nov 89 p 2

[Article by Chen Dong [7115 2639]]

[Excerpts] In the spring of 1989, "cold fusion" swept the science and technology world like a tidal wave; as the weather got warmer, the interest had cooled off. Facing the challenge, nuclear scientists worked even more intensely on research in thermonuclear fusion. It appears that there is still a long way to go before mankind's energy problem can be totally solved.

To find out the progress of China's research on thermonuclear fusion, this reporter visited the Institute of Atomic Energy (located in the southwest suburb of Beijing), one of China's largest multi-disciplinary nuclear-science research centers.

Deputy Director Professor Wang Naiyan [3769 0035 1750] of the Science and Technology Committee at the Institute greeted me enthusiastically and told me that: "To achieve controlled nuclear fusion, one must satisfy a number of difficult conditions; one is high temperature and the other is the Lawson criterion. Fusion requires the confinement of plasma at a hundred million degrees to a finite volume for a long enough time period. Scientists have been working for a long time on solving this problem. China is currently following two approaches, magnetic confinement and inertial confinement (laser or particle beam). We are working hard on the latter."

In a plain office, I met Professor Wang Ganchang [3769 3227 2490], who was working at his desk. Wang, 82, is one of the founding fathers of China's experimental nuclear physics, cosmic-ray physics, elementary-particle physics and nuclear weapons research. He is also China's pioneer in inertial confinement fusion. In 1964, Wang and Basov, a member of the Soviet Academy of Sciences, independently proposed the idea of hitting a target with laser in order to achieve nuclear fusion. Wang led the scientists and technical staff at SIOFM in the development of high-power neodymium glass lasers and target research, and was later appointed the Deputy Minister of Nuclear Industry and Director of the Institute of Atomic Energy. He personally led the establishment of laboratories for basic research on particle beams and for research on electron-beam-pumped krypton-fluoride (KrF) excimer laser drivers. He is now the Director Emeritus of the Institute of Atomic Energy and frequently comes to the laboratory in his busy schedule to direct research in this area.

Wang talked about inertial confinement with a high spirit: "Although inertial confinement started about 20 years later than magnetic confinement, it almost appears to be prevailing at this time. New results in laser fusion from the various laboratories in the world are very encouraging. The Livermore Laboratory used lasers to hit a black cavity target; they exceeded the Lawson criterion and reached a temperature of 20 million degrees. It looks like the scientific feasibility of controlled nuclear fusion is around the corner." When the conversation turned to the need for repetitive-frequency laser drivers in pure-fusion nuclear power plants of the future, Wang stressed that: "The KrF laser has very unique advantages. First, it is a gas laser and can be run at repetitive frequency; secondly, it has a suitable wavelength in the ultraviolet region; thirdly, its efficiency is high; and finally, its cost is relatively low. It is therefore a promising high-power laser-fusion driver, and has received a great deal of attention internationally. The United States has built 10-kilojoule devices and dozens of 100-joule devices exist in England, Japan and the United States. We are also working hard on this and have obtained some results. As long as the state supports us with the necessary manpower and funding, our effort may lead to some breakthrough that will make China a leader in the world."

Pointing to Professors Wang Naiyan and Shan Yusheng [0830 3768 3932] (Laser and Particle-Beam Laboratory Director) and other young researchers, Wang Ganchang continued: "These people should be commended for doing good work under very adverse conditions. Whether China can come out in front in the race toward controlled fusion is all dependent on them." [Passage omitted]

According to Wang Naiyan, SIOFM built a six-beam neodymium-glass laser 10 years ago. Recently, they have also built the "Magic Light" device and established a joint laboratory with the China Institute of Engineering Physics to conduct creative research. They have gained a certain international stature. After a five-year effort, the China Institute of Atomic Energy has achieved a 30-Joule KrF laser, with a power of 600 megawatts. He said with confidence that: "Since the fuel for nuclear fusion—deuterium—comes from the ocean, once the obstacle of fusion is overcome, the humankind will have an inexhaustible, clean, and economic source of energy. This enticing prospect has resulted in stiff competition in the race toward controlled nuclear fusion. The next few years will be crucial; we still need to put in more effort to make Chinese science prevail."

We gathered in front of the 30-Joule KrF laser device. It was designed and built by Chinese scientists and technical personnel with very little resources. According to Director Shan, their work began in 1984 under the

direction of Professor Wang Ganchang. They conducted basic research in KrF excimer-laser inertial-confinement fusion using an 80-gigawatt intense-current pulsed-electron-beam accelerator. They started at 6 Joules and reached 12.5 and 19 Joules after extensive experimental and theoretical research in large-area diodes, beam transport and laser devices. In April 1989, they achieved 30 Joules. In order to improve the results, a new accelerator has been built. The 30-Joule unit is currently under revision so that they may reach the goal of 100 Joules early next year [1990]. The 100-Joule level is an important step and is the present state-of-the-art in advanced countries. Once this threshold is crossed, a lot of other work will open up. So far the Chinese laboratory is still several times lower in laser energy compared to other advanced international laboratories; more work is needed in improving the beam quality. An international symposium on excimer lasers will be held in Beijing in the first half of 1990. This indicates that China is playing a role in this field.

I noticed that on the guest book there were warm words of encouragement written by world famous scientists and by renowned Chinese scientists like Zhou Peiyuan [0719 1014 3293], Tang Aoqing [0781 2407 1987], Zou Jiahua [6760 1367 5478], Chen Nengkuan [7115 5174 1401], Yu Min [0060 2404], and Cheng Kaijia [4453 7030 3946]. Director of the Chinese Chemistry Society and Academic Committee member Professor Xu Guangxian [1776 0342 2009] wrote the following words: "Personally I think cold fusion, even if confirmed, will be a weak effect and at least 40 to 50 years from application. On the other hand, thermonuclear fusion experiments are much closer to being practical. I wish you success!"

I also understood that since the 1950's most of China's known scientists in nuclear science have concentrated in this location. Now several decades have passed and these thousands of scientists still remained in this mountainous area far from the cities, enduring the inconvenience and difficult living conditions. Over the years they have provided nearly 5,000 cadres in science and technology and in management, and obtained more than 4,000 important research results.

I was deeply moved by the dedication of the Chinese scientists and encouraged by their fighting spirit. I silently pray that they excel in the severe competition of controlled thermonuclear fusion.